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FOREST PEST MANAGEMENT

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Forest Service

Forest Pest Management
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3430 BIOLOGICAL EVALUATION
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A PONDEROSA PINE PEST COMPLEX

Choristoneura lambertiana (Busck)
Neophasia menapia (F.& F.)
Zelleria haimbachii (Busck)
Pityophthorus aquilus Blackman

ON THE SAN JUAN NATIONAL FOREST
AND ADJACENT LANDS

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INTRODUCTION

For the last several years an insect complex comprising the pine budworm, Choristoneura lambertiana (Busck); pine butterfly, Neophasia menapia (Felder and Felder); and pine needle sheathminer, Zelleria haimbachi (Busck) has caused varying levels of ponderosa pine defoliation on the San Juan National Forest and adjacent lands in southwest Colorado.

Forest Pest Management became aware of the outbreak in 1981 during western spruce budworm, Choristoneura occidentalis (Freeman), surveys of the area. At that time, adults of the three species were observed in large numbers along Highway 550 north of Durango and along Highway 160 west of Pagosa Springs. As the damage by these insects continued to expand and intensify, concern for the defoliated pines increased.

In the last five years tree mortality has occurred among trees which have been simultaneously damaged by the pine budworm and pine butterfly. Most of the mortality is on or near recently developed sites. It is suspected the ponderosa pine mortality is resulting from the cumulative effects of defoliation and site disturbances such as root damage, irrigation, or changes in water table.

During the last decade in southwest Colorado, many ponderosa pine stands appear to have declined in vigor even in undeveloped areas where defoliators are not active. No single causal agent can be blamed for this decline. Climate (drought), water table drop, advanced stand ages, and reduced air quality are all possible contributors. Symptoms of this decline include reduced growth, discolored needles, and premature needle drop. It is possible that the unusually large number of concurrent insect outbreaks in these forests also is a symptom of the decline.

As the damage by these insects continued to expand and intensify, concern for the defoliated pines on private land increased. In response to this concern, the Pagosa Springs Rotary Club coordinated efforts to protect high value pines in the Pagosa area. The Club made bulk purchases of ACECAP® insecticide implants at reduced costs and hired a professional consulting Forester to inspect trees for private landowners. The Forester's job was to determine if protection of the trees was necessary. No formal insect population or defoliation data were recorded. Over 25,500 implants were sold and an estimated 3,500 trees were treated. The average cost of treatment to the landowner was about $5.11 per tree. The average diameter of the treated trees was between 9 and 10 inches. No formal evaluation of treatment results was made on private land.

On the San Juan National Forest trees at two areas were treated with ACECAPS®. The treated trees were at Ute Campground and at Twin Creek Village. Forest Pest Management established permanent plots at these areas and at four additional areas on the Forest. The locations of the six areas are shown in Figure 1. Larval population densities, 1984 and 1985 defoliation percentages, and pine budworm egg mass densities were determined at each area. The 1985 defoliation and egg mass data were used to evaluate the ACECAP® treatments. The 1985 egg mass and 1986 defoliation data will be used to predict annual defoliation levels in subsequent outbreaks.

EXTENT OF THE PINE DEFOLIATION

In 1985, aerial and ground surveys indicated approximately 215,000 acres of ponderosa pine were damaged by the insect complex on the San Juan National Forest and adjacent lands (Figure 1). Acres of pine defoliation by ownership are displayed in Table 1.

Table 1. Acres of Pine Defoliation in Southwest Colorado by Land Ownership - 1985

OWNERSHIP	ACRES
San Juan National Forest	101,479
Southern Ute Indian Reservation	11,509
Bureau of Land Management	1,238
State of Colorado	1,822
Private	99,143
TOTAL	215,191

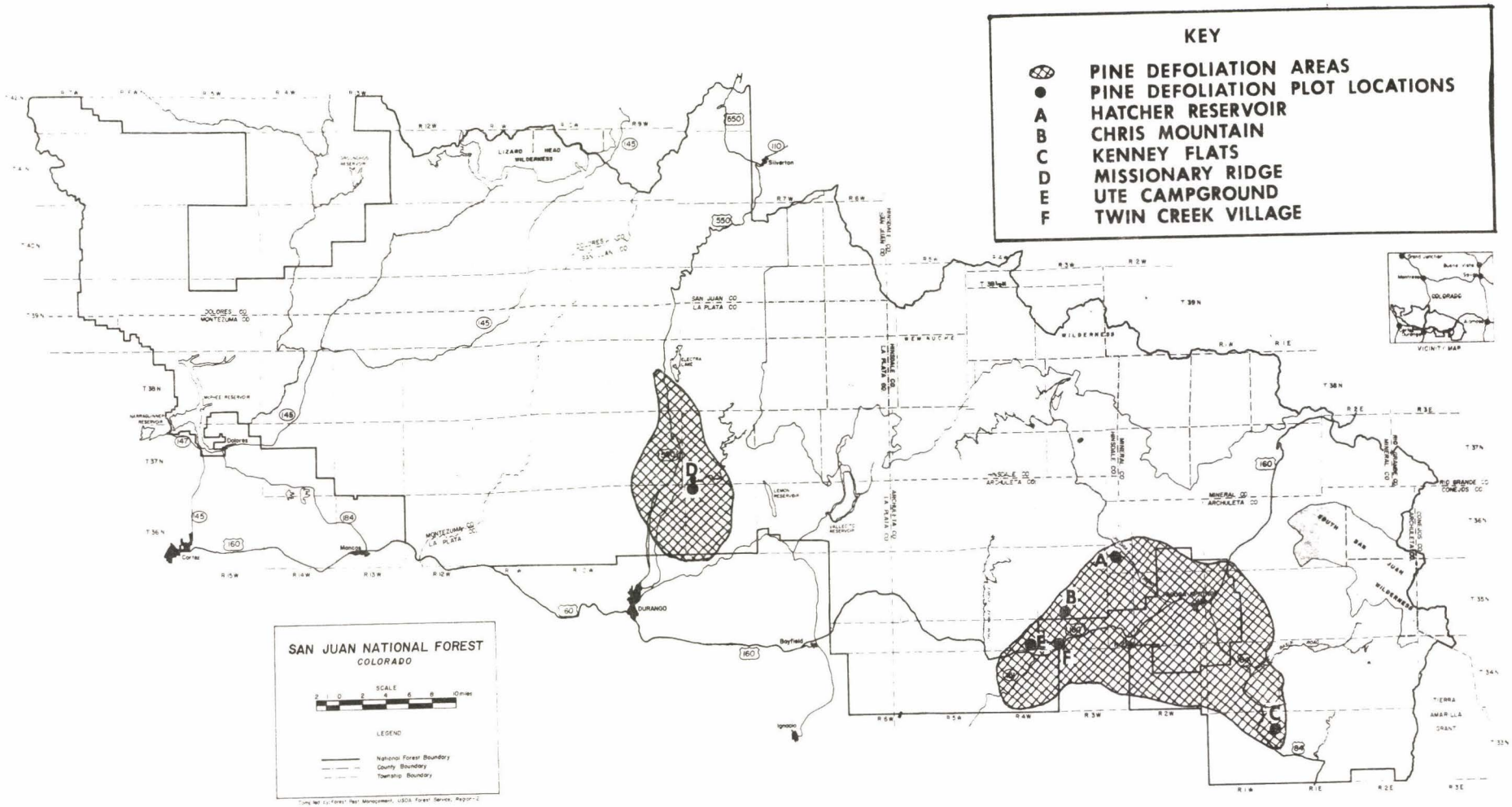

Figure 1. Area of pine defoliation on the San Juan National Forest and adjacent lands (letters indicate sampling sites).

TECHNICAL INFORMATION

INSECT: Pine budworm, Choristoneura lambertiana (Busck)

Hosts: Lodgepole pine, Pinus contorta Dougl.
Limber pine, Pinus flexilis James
Ponderosa pine, Pinus ponderosa Laws
Sugar pine, Pinus lambertiana Dougl.

Life History: The pine budworm completes one generation each year.

Stage	Time	Location on Host
Eggs	July & August	On older needles.
Small larvae (Instar I)	Overwinter	In silken cocoons under bark scales in cracks of branches and at bases of needles.
Larger larvae	June	At bases of new needles.
Pupae	July	On the shoots near the feeding site
Adult moths	July & August	In flight

Evidence of Infestation:

1. Small larvae (Instar I and II) mining within the sheaths of new needles in May and June.
2. Larger larvae found in webbing around the needles of the current year's shoots.
3. Crowns of severely defoliated trees appearing "scorched."
4. Crowns of trees damaged for several consecutive years appearing sparsely foliated.
5. Host trees dying from the top downward after several years of heavy defoliation.

TECHNICAL INFORMATION

INSECT: Pine butterfly, Neophasia menapia (Felder and Felder)

Hosts: Ponderosa pine, Pinus ponderosa Laws
Douglas-fir, Pseudotsuga menziesii (Mirb.) Franco

Life History: The pine butterfly completes one generation each year.

Stage	Time	Location on Host
Eggs	Overwinter	In a single row on needles near the tops of host trees.
Small larvae	June	Feeding in clusters, encircling the older needles much like sawfly larvae.
Large larvae	July	Feeding on mostly older needles.
Pupae	July & August	Attached to needles, twigs, or bark of host trees.
Adult moths	August	Flying around the tops of host trees.

Evidence of Infestation:

1. Sparsely foliated crowns of host trees.

2. Clouds of white butterflies fluttering about the tops of host trees.

TECHNICAL INFORMATION

INSECT: Pine needle sheathminer, Zelleria haimbachi Busck

Hosts: Ponderosa pine, Pinus ponderosa Laws.
Jeffrey pine, Pinus jeffreyi Grev. and Balf.
Lodgepole pine, Pinus contorta Dougl.
Jack pine, Pinus banksiana Lamb.
Hybrids of two and three-needle pines.

Life History: The pine needle sheathminer completes one generation each year.

Stage	Time	Location on Host
Small larvae (Instar I)	Overwinter	Mining needles
Large larvae	June	Beneath silken webbing feeding on needle sheaths and on elongating needles.
Pupae	July	On the damaged tips.
Adult moths	July	Flying around the tops of host trees.
Eggs	July & August	On current year's needles.

Evidence of Infestation

1. New needles dying just prior to or during elongation. Dead needles appear to be snipped off at the needle sheath.

2. At low damage levels, the severed new needles drop off so that by late summer the infestation becomes inconspicuous.

3. At severe damage levels almost all the new needles are killed and the resultant sparsely foliated tip remains obvious throughout the following year.

EVALUATION METHODS

Five permanently marked, 1/10 acre plots were established at each of seven areas. One 27-inch branch was pruned from the mid-crown of each of six dominant or codominant trees at each plot.

Defoliation

The 1984 defoliation estimates were based on the percent of needles missing from the 1984 growth as determined by an ocular examination. The 1985 defoliation estimates were made on the 1985 growth after all insect feeding ceased in late August.

To determine percent defoliation, 10 growing tips were randomly selected from each branch. Each tip was given a rating based on the percent of defoliation (Table 2). The total rating for each branch (10 tips) was recorded.

Table 2. Method Used to Rate the Defoliation of Branch Tips.

Percent Defoliation on Growth Being Evaluated	Tip Rating
0 %	0
1-25 %	1
26-50 %	2
51-75 %	3
76-100%	4

Pest Population Density

The total number of growing tips and total number of pests found on each branch was recorded. The pest population density for each area was expressed as the mean number of pests per branch tip.

Pine Budworm Egg Mass Density

To determine egg mass density, one 27-inch branch was pruned from the mid-crown of each of 6 dominant or codominant trees at each plot. The foliage samples were bagged, labeled, and transported to the laboratory. The area of each branch was determined. A stereoscope was used to separate new from old egg masses.

ACECAP^{R} Implant Treatments

ACECAPS^{R} are tubular plastic cartridges containing crystallized technical acephate (ORTHENE^{R}), an organophosphate insecticide. A perforated hard plastic shell protects a gelatin capsule containing the acephate. The cartridge is tapped into thewoody tissue of the tree, where the sap dissolves and distributes the chemical.

Trees at two areas on the San Juan National Forest were treated with ACECAP 97^{R} cartridges, which contain 97 percent technical acephate. Twenty ponderosa pines

were treated at Ute Campground, and 57 were treated at Twin Creek Village. The ACECAPS® were applied in the manner described by Reardon (1984). One ACECAP® was implanted for every 4 inches of trunk circumference.

Post-treatment defoliation and pine budworm egg mass counts were made on treated and untreated trees at each of the two areas.

RESULTS

Defoliation

Defoliation levels declined from a mean of 65.4 percent in 1984 to 51.1 percent in 1985 (Table 3). The most severely defoliated of the 6 sampling areas was Missionary Ridge where an average of 58.9 percent of the 1985 growth was destroyed. The greatest decline in defoliation occurred at Chris Mountain. Ute Campground was the only survey area that experienced an increase in defoliation.

Table 3. Pine defoliation levels on the San Juan National Forest, 1984 and 1985.

AREA	Defoliation 1984	Defoliation 1985	Percent Change
Chris Mountain	77.1	47.6	-38.3
Hatcher Reservoir	56.1	49.1	-12.5
Kenney Flats	75.4	49.5	-33.8
Missionary Ridge	69.8	58.9	-10.9
Twin Creek Village (Untrtd.)	67.9	43.0	-36.7
Ute Campground (Untrtd.)	45.8	58.5	+27.7
SUMMARY	65.4	51.1	-14.3

Pest Population Densities

Our survey showed that the pine budworm is the most important pest in the complex (Figure 2). The maximum budworm densities ranged from 26.5 larvae per 100 branch tips on June 13 at Missionary Ridge to 70.9 on June 12 at Chris Mountain (Table 4).

The second most important pest in the complex was the needle sheathminer. The highest sheathminer density was 13.2 larvae per 100 branch tips at Missionary Ridge on June 20. Significant parasitism by the wasp, Apanteles (probably fumiferanae) contributed to a 70 percent decrease in sheathminer numbers between June 20 and June 27 at Missionary Ridge.

No pine butterfly larvae were found at any of our sampling areas in 1985 despite a spectacular adult flight in the Pagosa Springs area in 1984. The insect may still be active at low levels in the area but it did not occur in any of our sampling sites.

A twig beetle, Pityophthorus aquilus Blackman, was found causing tip dieback. (Figures 3A, 3B) at Missionary Ridge and Kenney Flats. By the end of June at Missionary Ridge almost 6 percent of the branch tips sampled had been killed by this beetle.

Figure 2. Mature larva and pupa of the pine budworm Choristoneura lambertiana (Busck) and damage on ponderosa pine.

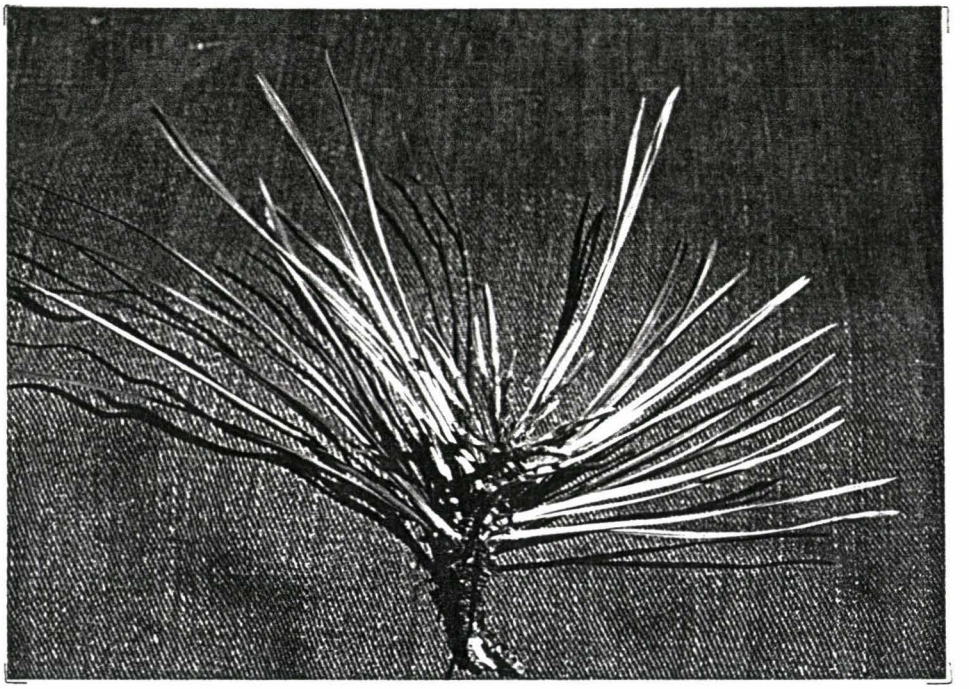

Figure 3A. Ponderosa pine tip killed by Pityophthorus aquilus Blackman.

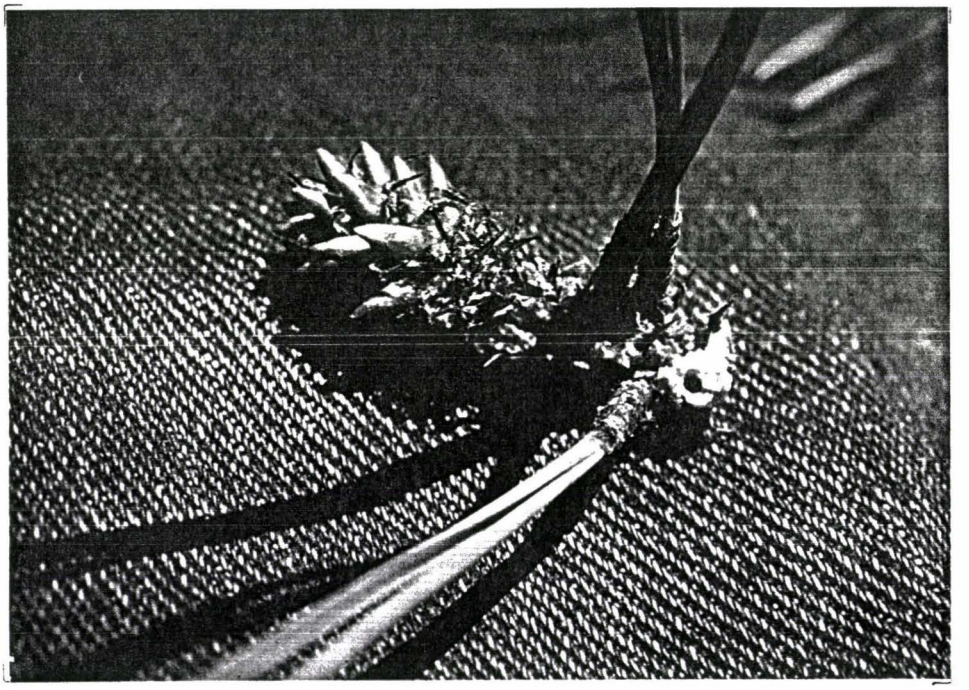

Figure 3B. Pitch tube at entry site of Pityophthorus aquilus Blackman.

Table 4. Population densities of ponderosa pine pests at six survey areas on the San Juan National Forest, 1985.

Area and Survey Date	Insects per 100 Branch Tips		
	Pine Budworm	Pine Needle Sheathminer	Twig Beetle
Chris Mountain			
6/12	70.9	0.0	0.0
6/19	65.8	0.0	0.0
6/26	52.1	1.3	0.0
Hatcher Reservoir			
6/11	47.4	0.0	0.0
6/18-19	57.9	0.5	0.0
6/25	46.1	0.6	0.0
Kenney Flats			
6/10	46.0	0.0	0.0
6/18	43.8	1.4	0.0
6/26	38.2	0.8	0.4
Missionary Ridge			
6/13	26.5	12.4	1.8
6/20	13.4	13.2	5.7
6/27	10.8	3.9	5.8
Twin Creek Vill.			
6/25	33.1	0.0	0.0
Ute Campground			
6/25	38.9	0.0	0.0

Pine Budworm Egg Mass Density

Pine budworm egg mass densities ranged from .18 at Missionary Ridge to 6.38 at Twin Creek Village (Table 5). Next year, an attempt will be made to correlate this data with the 1986 defoliation levels at each of the sampling areas.

Table 5. Pine budworm egg mass densities at each of the sampling areas on the San Juan National Forest --- 1985.

AREA	Egg Masses Per M^2 of Foliage
Chris Mountain	2.31
Hatcher Reservoir	1.36
Kenney Flats	2.31
Missionary Ridge	.18
Twin Creek Village	6.38
Ute Campground	5.26
Mean	2.97

Evaluation of ACECAP^{R} Implant Treatments

Pine budworm larval density, egg mass density, and defoliation data taken at the two treatment areas are displayed in Table 6.

Pine budworm larval population reduction provided by the implants was poor. The unadjusted population reduction was 39 percent at Twin Creek Village and 51 percent at Ute Campground.

The apparent foliage protection was 74 percent at Twin Creek Village and 44 percent at Ute campground.

Pine budworm egg mass densities at both areas were lower on treated trees than on untreated trees. However, these differences were not statistically significant.

Table 6. Results of ACECAP^{R} implant treatments on the San Juan National Forest --- 1985.

	Untreated Trees	Treated Trees	Percent Reduction	Significant (@p =.01)
Twin Creek Village				
Pine Budworm Larval Density (larvae/100 tips)	33.1	20.2	39[a]	- -
Defoliation (%)	43	12	72	Yes
Pine Budworm Egg Mass Density (EM/M^2)	6.4	1.7	73	No
Ute Campground				
Pine Budworm Larval Density (larvae/100 tips)	38.9	19.1	51[a]	- -
Defoliation (%)	59	33	44	Yes
Pine Budworm Egg Mass Density (EM/M^2)	5.3	2.1	60	No

a/ unadjusted for natural mortality

Figure 4. Natural defoliation differences among trees damaged by pine budworm.

DISCUSSION

The vigor of ponderosa pines in southwest Colorado appears to be declining. Uninfested trees with discolored needles and sparse crowns are prevalent throughout the area. It is possible that the concurrent outbreaks of the insects described in this evaluation are other symptoms of this decline. The presence of twig beetles such as P. aquilus Blackman is definitely an indicator that the affected trees are stressed or weakened. Continued damage by these insects will further accelerate this apparent decline.

The pine budworm is the most prevalent pest in the forest insect complex of southwest Colorado. Until more is known about the true cause(s) of the apparent conifer decline, the pine budworm should be the focus of any mitigation efforts.

The amount of damage caused by the pine budworm in 1985 varied from tree to tree within a stand (Fig. 4). The average amount of defoliation in the Pagosa Springs area was 15 percent lower in 1985 than it was in 1984. Damage levels in 1986 are expected to be equal to or less than those experienced in 1985. This expectation is based on observation and experience rather than on any data collected. Egg mass density and defoliation data will again be collected in 1986. After the 1986 data collection, we will have a better capability to predict pine budworm defoliation using egg mass density information.

The ACECAP^{R} treatments provided poor budworm population reduction and only mediocre foliage protection. Pest management will sample the implanted trees again in 1986 to determine if there is any carryover effect on the pine budworm population.

Implanting ACECAPS^{R} causes a discolored area around each hole (Reardon, 1984). This discoloration might interfere with the upward movement of water within the wood. Implant holes also may serve as entry sites for pathogenic micro-organisms. Treating the same trees again with ACECAPS^{R} will increase the risk of infections.

RECOMMENDATIONS

1. Since pine defoliation in southwest Colorado is a concern to private landowners as well as Federal land managers. State and Federal cooperative surveys should be planned for this area. The data collected from the surveys should be used to monitor the pine defoliator populations and to facilitate the planning of suppression activities.

2. Defoliator suppression on pines in southwest Colorado should focus on the most important insect in the defoliator complex in the Pagosa Springs area. Any efforts to reduce pine defoliation near Pagosa Springs should focus on the pine budworm.

3. Suppression of pine defoliators should be limited to high value ornamentals on private lands and on esthetically important trees on developed National Forest sites.

4. Aerial application of pesticides should be used to control pine budworm on large areas whenever economically and environmentally feasible. For smaller accessible areas, trees should be sprayed with ground equipment.

Recommendations for pesticide treatments are detailed in Table 7. These treatments were used successfully on private lands in the Pagosa Springs area in 1985.

5. In 1985, ACECAP^{R} implants were only marginally effective against pine budworm on forest trees. The small amount of foliage protection and insect population reduction provided by the ACECAPS^{R} was not worth the risk of serious tree injury associated with the implant wounds.

It is possible that irrigated ornamentals and more vigorous natural pines can more effectively translocate the acephate from the wood to the foliage and thus provide better insect control. ACECAP^{R} implants should be further evaluated on trees growing under those conditions.

6. The results of large-scale suppression activities on private lands should be evaluated particularly when the suppression method lacks efficacy data. These results should be reported so that better recommendations can be made for future suppression projects.

Table 7. Pesticides recommended for control of pine budworm in southwest Colorado.

		AERIAL APPLICATION					GROUND APPLICATION				
Pesticide	Environmental Precautions	Formulation	Rate	Expected Results	Cost/ Acre	Application Time A/	Formulation	Rate	Expected Results	Cost/ Tree	Application Time A/
Carbaryl	Avoid application to water. Toxic to bees.	Sevin 4-oil®	1 qt/ acre	Good	$15-$20	20% instar V	4 lbs Ai/gal	1 qt/ 100 gals water	Good	$8-$10	20% instar V
Fluvalinate	Avoid application to water. Highly toxic to fish	Mavrik aquaflow®	.03-.08 lbs. Ai/acre	Good	$15-$20	20% instar V	Mavrik aquaflow®	2-5oz/ 100 gals. water	Excellent	$8-$10	20% instar V

A/ In 1985, the proper time to spray was between June 14 and June 21.

LITERATURE CITED

Reardon, R.C. Spruce Budworms Handbook. How to protect individual trees from western spruce budworm by implants and injections. USDA Forest Service. Agriculture Handbook No. 625, August 1984, 16p.